

INCREASING MOTORIST COMPLIANCE AND CAUTION AT STOP SIGNS

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This study evaluated strategies to improve motorist compliance and caution at three stop-sign-controlled intersections with a history of motor vehicle crashes. The primary intervention was a light-emitting diode (LED) sign that featured animated eyes scanning left and right to prompt drivers to look left and right for approaching traffic. Data were scored from videotape on the percentage of drivers coming to a complete stop and the percentage of drivers looking right before entering the intersection. Observational data were collected on the percentage of right-angle conflicts (defined as braking suddenly or swerving from the path to avoid an intersection crash). The introduction of the LED sign according to a multiple baseline across the three intersections was associated with an increase in the percentage of vehicles coming to a complete stop at all three intersections and a small increase in the percentage of drivers looking right before entering the intersections. Conflicts between vehicles on the major and minor road were also reduced following the introduction of the animated eyes prompt.

DESCRIPTORS: technology, stop signs, safety, prompts, transportation safety

Stop signs are used at intersections to control potentially conflicting traffic movements and thus prevent crashes. At four-leg intersections controlled by two-way stop signs, drivers on the minor approaches (with stop signs) typically are required to stop and yield the right of way to those approaching on the major roads (without stop signs). In addition to stopping, drivers must look left and right to identify large enough gaps in the conflicting traffic to permit access onto or across the

major road. Drivers who fail to stop or, after stopping, proceed without looking for traffic on the major road create a substantial crash risk. More than 700,000 motor vehicle crashes occur at stop signs each year (National Highway Traffic Safety Administration, 1998). About one third of these crashes result in police-reported injuries, and more than 3,000 are fatal. Motorists' disregard of traffic-control devices is a leading cause of police-reported urban crashes. Retting, Williams, Preusser, and Weinstein (1995) reported that 41% of crashes that involved drivers failing to obey traffic-control devices in four cities occurred at stop signs, with virtually all cases occurring at intersections with two-way stop-sign control.

Massie, Campbell, Blower, Waller, and Wolfe (1991) reported that failure-to-yield crashes at nonsignalized intersections fall into two major categories: cases in which no claim of having stopped was reported by police, and cases in which the driver claimed

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to have stopped but then pulled out and collided with an oncoming vehicle. Older drivers were substantially overrepresented in the former group, whereas younger drivers were overrepresented in the latter group.

Several studies have documented poor compliance at stop signs, characterized by failure to stop or to look adequately for oncoming traffic (McKelvie, 1986; Pietrucha, Opiela, Knoblauch, & Crigler, 1989). Treat et al. (1979) reported improper lookout to be the leading cause of crashes, accounting for nearly one fourth of all investigated motor vehicle collisions. Carstens (1983) reported that improvements in stop-sign visibility and installation of rumble strips at stop signs were not associated with crash reductions. Thus, although the ability of drivers to see stop signs is important, it is apparently not a major factor influencing driver behavior.

Therefore, greater emphasis should be placed on the actions of drivers stopped at stop signs that ensure the identification of large enough gaps in conflicting traffic to permit access onto or across the major roads. One way to prompt observing behavior is to post a sign with a text message that directly prompts looking. Retting, Van Houten, Malenfant, Van Houten, and Farmer (1996) increased pedestrian observing behavior and reduced motor vehicle/pedestrian conflicts by posting "LOOK FOR TURNING VEHICLE" signs next to the pedestrian walk signal. Another strategy that may increase the salience of such prompts is to use an illuminated pair of eyes that look back and forth to model looking behavior. Van Houten, Retting, Van Houten, Farmer, and Malenfant (1999) added animated eyes to the pedestrian walk signal to prompt pedestrians to look for turning vehicles. Animated eyes have also been used at parking garage exits and midblock crosswalks to prompt motorists to look for pedestrians (Van Houten & Malenfant, in press; Van Houten, Van Hou-

ten, Malenfant, & Andrus, 2000). In each of these studies the animated eyes were effective in increasing looking and reducing conflicts between motorists and pedestrians. The purpose of this study was to extend the generality of these studies by evaluating the use of a textual prompt and an animated eyes prompt to improve motorist compliance and caution at stop signs.

METHOD

Participants and Setting

Participants were motorists at one of three intersections in St. Petersburg, Florida, controlled by two-way stop signs. These intersections were selected because they were sites of four or more crashes in a 3-year period and afforded access for unobtrusive observation. Site A was the stop sign for westbound traffic on 34th Avenue North (two-way two-lane road) at the intersection of 16th Street (two-way four-lane road); a flashing red beacon and a large stop sign were placed at this site. Site B was the stop sign for northbound traffic on 22nd Street (two-way two-lane road) at the intersection of 5th Avenue North (two-way four-lane road). Site C was the stop sign for southbound traffic on 16th Street (two-way two-lane road) at the intersection of 70th Avenue North (two-way two-lane road); southbound and northbound traffic were divided by a wide median. Between January 1995 and December 1997, there were seven injury crashes at Site A, 11 injury crashes at Site B, and four injury crashes at Site C.

Apparatus

A "LOOK BOTH WAYS" sign and a light-emitting diode (LED) sign that featured animated eyes scanning left and right were used to prompt drivers to look left and right for approaching traffic (see Figure 1). The "LOOK BOTH WAYS" sign measured 61 cm wide by 24 cm high and had 10.2-



Figure 1. Photographs of the “LOOK BOTH WAYS” prompt and the animated eyes prompt.

cm high black letters on a white background. The animated eyes consisted of blue (450 nm) LEDs that scanned left and right at a rate of 1 cycle per second. The eyes were 8.7 cm apart, and each eye measured 19 cm wide and 10.2 cm high. The animated eyes sign was placed 81 cm in front of the stop sign by affixing it on top of a 172-cm high channel post with a bolt and wing nut. A microwave sensor detected approaching vehicles and activated the LED eyes, which remained on for 6 s after vehicle motion ceased. In a previous study, a similar device was found to increase pedestrians’ observing behavior before crossing the street and to reduce pedestrian/motor vehicle conflicts (Van Houten et al., 1999). The “LOOK BOTH WAYS” sign was installed only at Site 1; the animated eyes were installed at all three sites.

Experimental Design

A multiple baseline design across sites (intersections) was employed in this experi-

ment. Following a baseline condition, the sign was installed at Site A. The sign then was replaced by the animated LED eyes while the remaining two sites remained in the baseline condition. The animated LED eyes then were installed at the remaining two sites.

Measures

Observers who were not informed of the study’s purpose scored from videotapes whether the vehicle came to a complete stop and whether the driver looked right before entering the intersection. Observers were instructed to score a vehicle as coming to a complete stop if the tires stopped rolling prior to the vehicle entering the intersection. Looking to the right was defined as the driver turning his or her head rightward within 2 s before entering the intersection.

Videotapes were scored in a random order. The primary observer never became aware of the purpose of the experiment. A

second observer rescored two tapes from each condition of the study. Interobserver agreement on the occurrence of not coming to a complete stop and not looking right was calculated by dividing the percentage of times both observers agreed on the occurrence of behavior by the number of times they agreed on the occurrence of the behavior plus the number of times they disagreed. Interobserver agreement on the occurrence of not coming to a complete stop averaged 86% (range, 82% to 90%), and interobserver agreement on not looking right averaged 75% (range, 72% to 80%).

Right-angle conflicts were recorded by an observer at the site, because conflict scoring required a full view of the intersection and approaching vehicles on the road on which drivers had the right of way. Conflicts were defined as the observed vehicle coming to a sudden stop after starting to enter the intersection, or an approaching vehicle on the major road coming to a sudden stop because the observed vehicle proceeded without the right of way. A measure of interobserver agreement was obtained for two complete sessions (percentage of observations) during each condition of the experiment by having a second observer independently score conflicts. Percentage agreement on the occurrence of conflicts was calculated by dividing the number of times both observers scored a vehicle as having a conflict by the number of times one observer scored a vehicle as having a conflict and the other did not. Agreement on conflicts was 90%.

Data Collection

Field observations occurred between February 23 and July 3, 1999, with most of the data collected between April and June (no data were collected during rainy conditions). The video camera was set up on a tripod facing the back of the stop sign at the start of each session. At Site A, the camera was located in front of a plant next to the curb

and was covered with a camouflage net; at Site B, the camera was placed in the back of a pickup truck in a driveway; at Site C, the camera was placed in the planted median next to some shrubs. After setting up the camera the observer recorded data on conflicts for 50 consecutive vehicles and then stopped filming. It typically took between 30 and 60 min to collect data on 50 consecutive vehicles, depending on the site. Observations were made from inside the observers vehicle which was parked in a location that afforded a complete view of the intersection. A total of 126 data-collection sessions were conducted. During each session, a little more than 50 vehicles approaching the stop signs were recorded on videotape. For some of the sessions, a few of the observations (recorded on videotape) were lost due to sun glare on the windshield or wind that moved the video camera out of position.

RESULTS

The percentage of motorists coming to a complete stop is presented in Figure 2. During baseline, 52%, 66%, and 46% of motorists came to a complete stop at Sites A, B, and C, respectively. The installation of the "LOOK BOTH WAYS" sign at Site A was associated with a slight increase in compliance with the requirement to come to a complete stop ($M = 59\%$ during this condition). Following the introduction of the animated LED eyes in front of the stop signs, all three sites showed an increase in the percentage of vehicles coming to a full stop ($M = 78\%$, 80% , and 74% for Sites A, B, and C, respectively). On average, the percentage of vehicles coming to a complete stop before entering the intersections across all three sites increased from 55% to 77%.

The percentage of drivers looking right before entering the intersection is presented in Figure 3. During baseline, 75%, 72%,

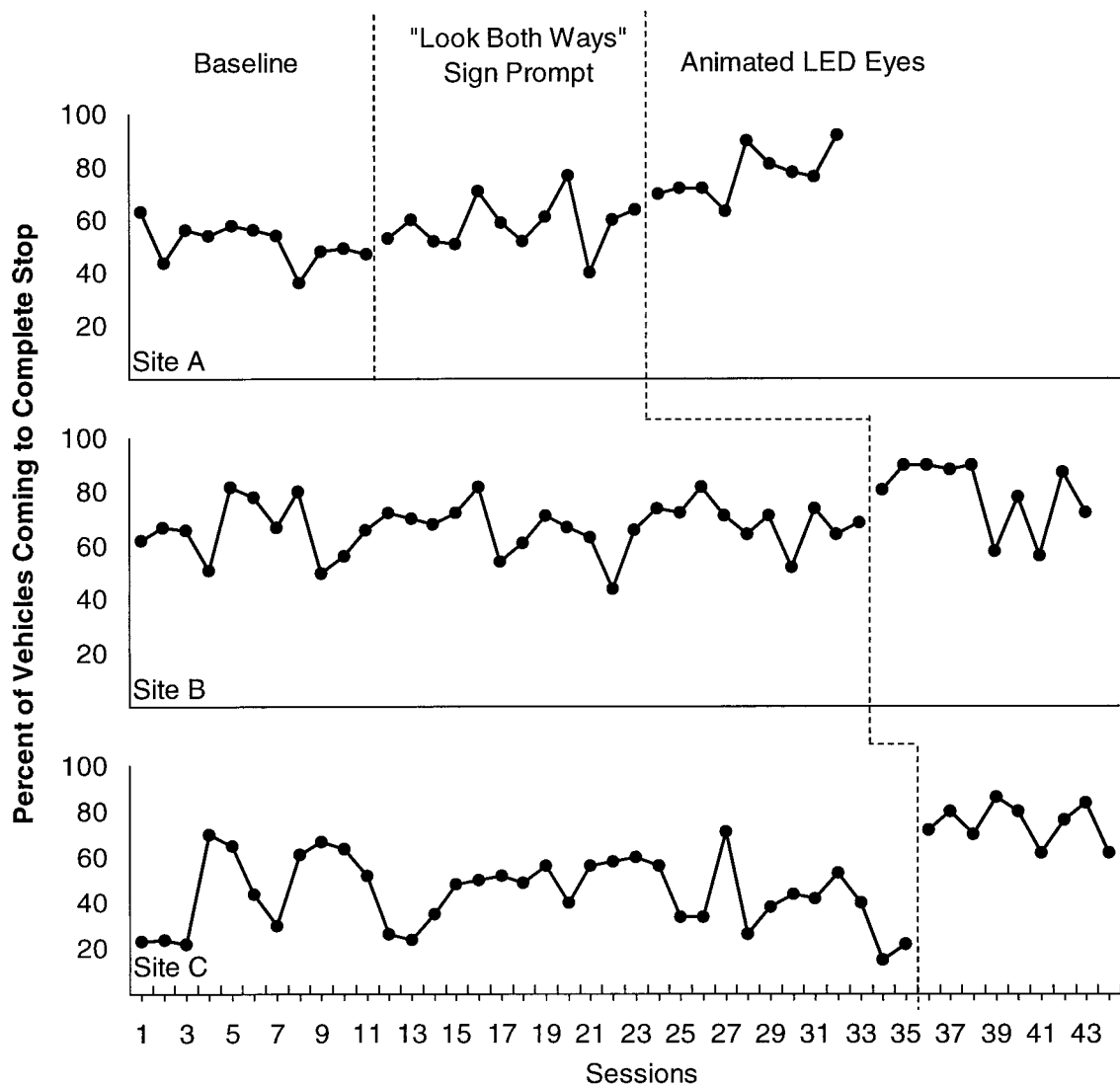


Figure 2. The percentage of vehicles coming to a complete stop at each of the four sites during each session of the experiment.

and 87% of motorists looked right at Sites A, B, and C, respectively. The introduction of the “LOOK BOTH WAYS” sign at Site 1 was not associated with an increase in the percentage of drivers looking both ways ($M = 74\%$ during this condition). Following the introduction of the animated eyes, the percentage of drivers looking right increased to 81%, 81%, and 92% at Sites A, B, and C, respectively. On average, the percentage

of drivers looking right before entering the intersections across all three sites increased from 79% to 85%. However, inspection of Figure 3 shows that a noticeable increase occurred only at Site B.

The number of right-angle conflicts per observation session (observational data were always collected on 50 vehicles) is presented in Figure 4. During baseline right-angle conflicts averaged 4.2, 5.1, and 3.1 at Sites

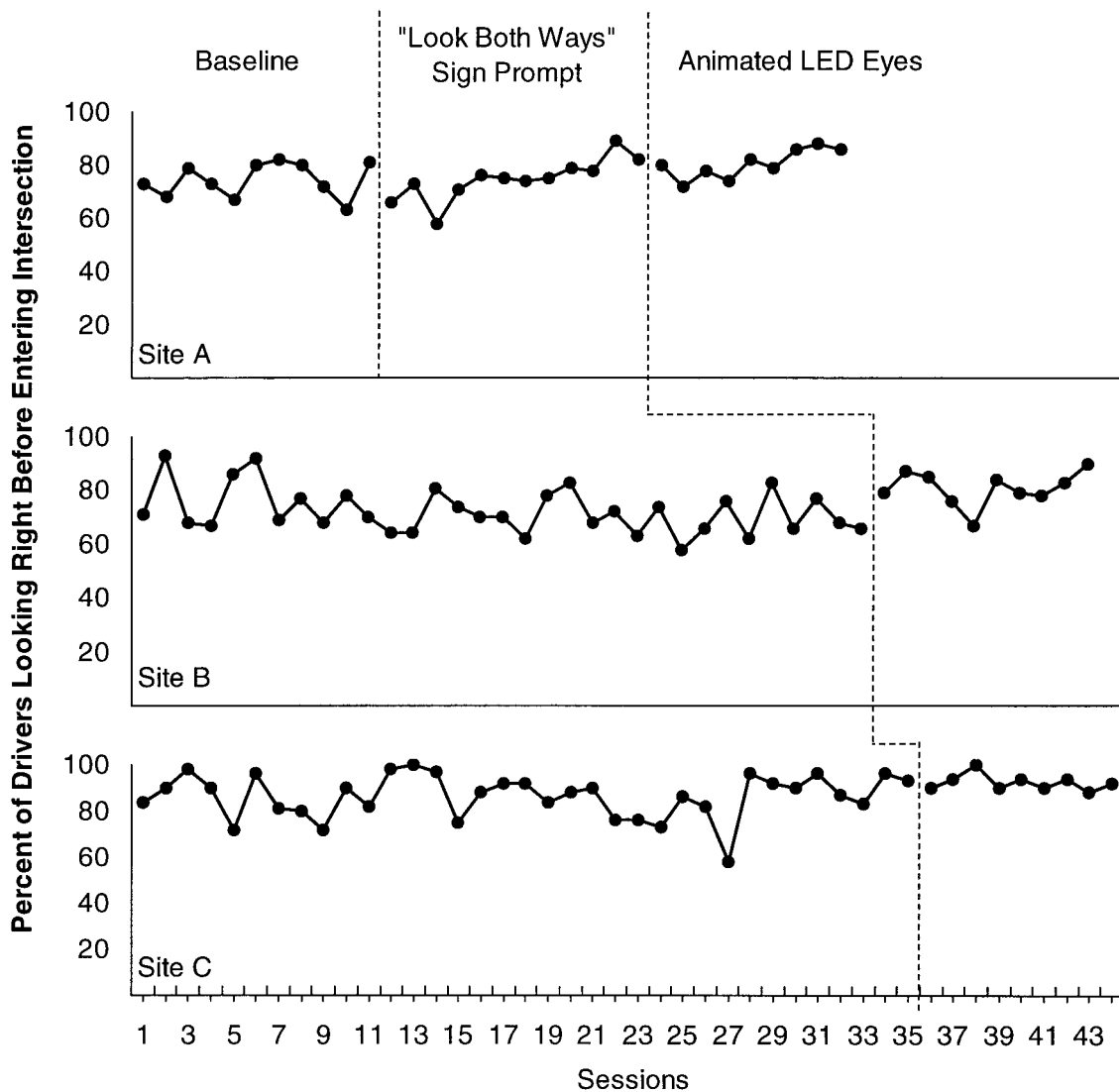


Figure 3. The percentage of drivers looking right before entering each intersection during each session of the experiment.

A, B, and C, respectively. The introduction of the "LOOK BOTH WAYS" sign at Site 1 was not associated with a decrease in the number of right-angle conflicts. Following the introduction of the animated eyes, right-angle conflicts decreased to 1.8, 1.5, and 0.9 at Sites A, B, and C, respectively. On average, the number of right-angle conflicts across all three sites decreased from 4 to 1.4.

DISCUSSION

Results of this study show that a prompt consisting of animated eyes that looked back and forth increased the percentage of motorists coming to a full stop and decreased the number of right-angle conflicts at three stop-sign-controlled intersections. The introduction of the eyes was also associated with a very modest decrease in the percentage of motorists not looking right before entering

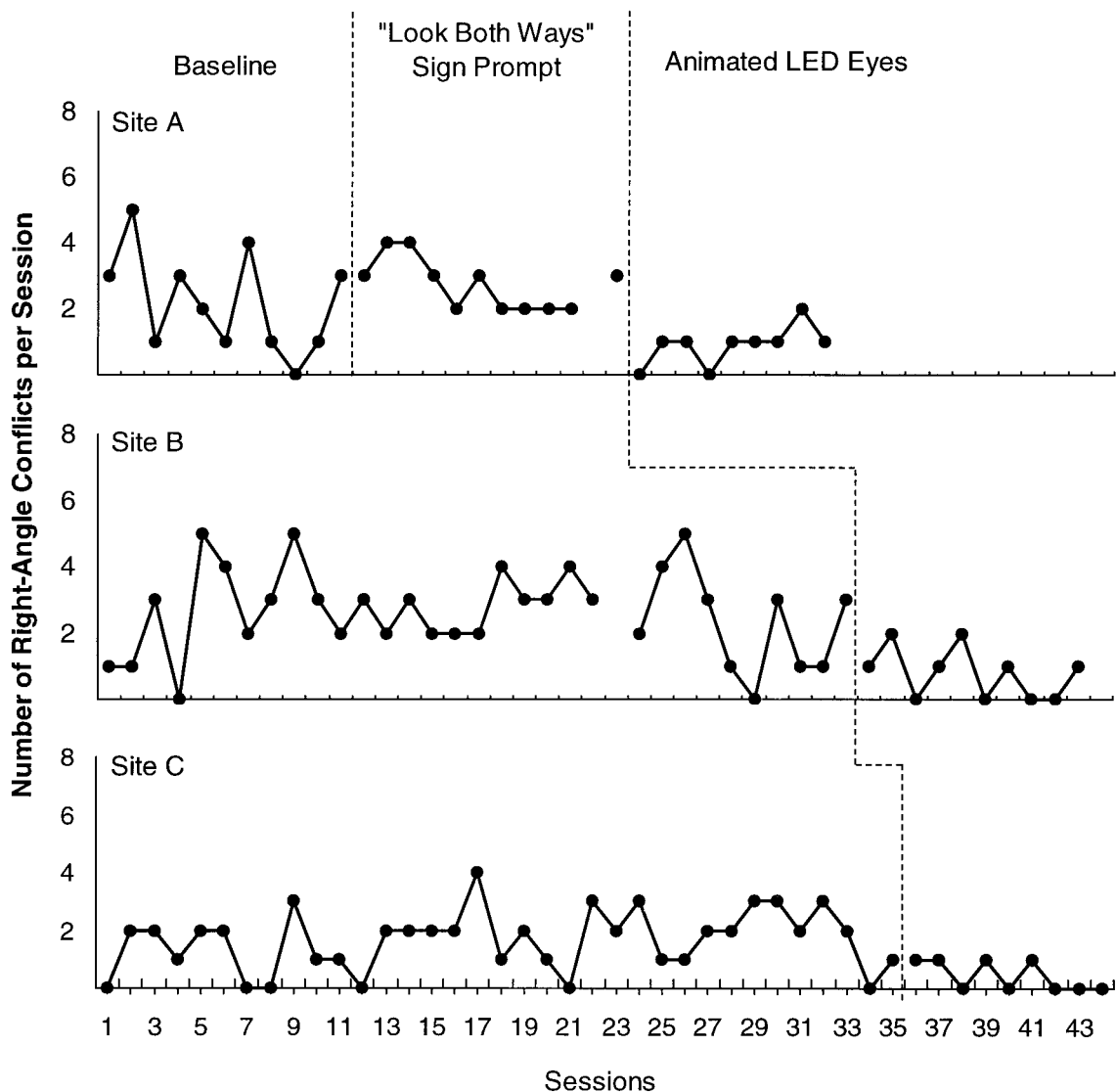


Figure 4. Number of right-angle conflicts per session.

the intersection. Although the animated eyes prompt increased the percentage of vehicles coming to a complete stop at all three intersections, the "LOOK BOTH WAYS" sign was not associated with any change in behavior at the one site where it was introduced.

One reason why the animated eyes prompt may have been more effective than the sign prompt is that the text-only message sign resembled many other signs that

were irrelevant to most drivers (e.g., the "TRUCK ROUTE" sign); therefore, drivers may have ignored a number of signs along the road. It is also possible that the animated eyes prompt was more salient than the sign because (a) it was illuminated, (b) it contained motion, (c) signal onset was associated with the vehicle approaching the intersection, and (d) the scanning eyes modeled the behavior being prompted. It is not possible to determine

the relative contribution of each of these factors is this study.

The increase in vehicles coming to a complete stop and the reductions in right-angle conflicts were much larger than the increase in the percentage of motorists looking right. The most likely reason for this discrepancy was that observers could not score subtle observing behavior from the tapes. Although observers could easily detect large head-turning movements, it was not possible to observe more subtle behaviors such as glancing back and forth with or without small head movements. One reason why it was difficult to score glancing looks was that, in most cases, the glare off the windshield of the vehicle resulted in seeing a dark outline of the driver's head with facial features barely visible.

It is not clear whether the increase in the percentage of drivers coming to a full stop would have persisted if the treatment had remained in effect for a longer period of time or had been applied to a very large number of sites. It was not possible to keep the LED display in place because of the temporary and portable nature of the experimental device. Thus, future research should attempt to distinguish sustainable benefits from possible novelty effects. The cost of the LED display is approximately \$300 plus installation and requires very little power to operate, so this device is potentially cost effective given the average cost of an injury crash.

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STUDY QUESTIONS

1. Describe two forms of driving behavior that the authors suggest contribute to a large number of vehicle crashes.

2. To what extent has increasing stop-sign visibility and installing rumble strips contributed to reductions in the occurrence of stop-sign-related vehicle crashes? What additional methods might be used to facilitate stop-sign compliance?
3. Describe the critical features of the two apparatus used in the current study.
4. How were data collected during field observations, and what three measures were used as the dependent variables?
5. Describe the experimental design used to evaluate the effects of intervention, and summarize the results that were obtained.
6. What features of the LED display may have contributed to its efficacy? How might the “LOOK BOTH WAYS” sign have been made more effective?
7. How did the authors explain the results obtained for drivers looking to the right?
8. What behavioral function might the LED apparatus have served, and why might one expect its effects to be relatively temporary?

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